Estimation of regional recharge in the HOBE catchment using data from a distributed soil moisture network

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The regional variation of recharge of ground water is dependent on a larger number of variables and conditions and is therefore difficult to quantify. In this study we have estimated regional recharge using data from a distributed network of soil moisture stations within the HOBE catchment. The network has been designed in an arrangement of three clusters along a long-term precipitation gradient and the stations have been distributed according to respective fractions of classes combining the prevailing land use, top- and subsoil conditions. At each of the 30 stations water content has been measured at three depths (0-5cm, 20-25cm and 50-55cm) for the period 2009-2011 at a temporal resolution of 30 minutes. The 1D soil-plant-atmosphere system model DAISY has been applied to each of the field locations to simulate the water balance of the root zone and the associated components of evapotranspiration and recharge. The 30 models have been formulated and parameterized using specific information on local climate, soil texture, land use and management. Each model was calibrated to the measured soil water content from the distributed network using the PEST (Parameter ESTimation) software. The calibrated parameters were saturated hydraulic conductivity Ks and van Genuchten parameter n as they were found most sensitive. The 30 sets of results were averaged to represent the mean conditions of the catchment. An effective parameterization was also determined by calibration against mean soil moisture and compared to the results obtained by using effective parameters using various averaging methods. The regional variation in groundwater recharge, actual evapotranspiration and soil water content in the catchment was dependent on land use. The simulated results showed that the largest recharge was found at the agricultural sites (554 mm/yr) and the lowest at the forested sites (257 mm/yr). Correspondingly, the highest actual evapotranspiration was found at the forested sites (614 mm/yr) and the lowest at the agricultural sites (444 mm/yr). Heath was in between with a recharge rate of 467 mm/yr and an actual evapotranspiration of 499 mm/yr. The simulated results of soil water content matched well with the corresponding observations from the 30 soil moisture network sites. Further, the simulations compared well with local flux measurements of actual evapotranspiration and recharge represented by the discharge measured at the catchment outlet. Overall, effective parameterizations using both inverse determination and simple averaging techniques offered acceptable matches to the mean conditions at catchment scale.